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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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Development of USES Aptitude Test Battery

for

Inspector, Mechanical and Electrical

(elec.equip.) 6-99.435

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Technical Report on Development of USES Aptitude Test Battery

For .....

Inspector, Mechanical and Electrical

(elec. equip.) 6-99.435

710.384

B-635 or S-355

U. S. Employment Service
in Cooperation with
California and Ohio State Employment Services

November 1965

GATB Study #2575

DEVELOPMENT OF USES APTITUDE TEST BATTERY

For

Inspector, Mechanical and Electrical (elec. equip.) 6-99.435

B-635 or S-355

This report describes research undertaken for the purpose of determining General Aptitude Test Battery (GATB) norms for the occupation of Inspector, Mechanical and Electrical (elec. equip.) 6-99.435 (3rd Edition DOT code 710.384). The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB, B-1002 Scores
N- Numerical	95
S- Spatial	90
M- Manual Dexterity	80

RESEARCH SUMMARY

Sample:
50 employed workers (5 females and 45 males) working as Inspectors, Mechanical and Electrical in California and Ohio.

Criterion:
Supervisory ratings

Design:
Concurrent (test and criterion data were collected at approximately the same time).

Concurrent Validity:
Phi Coefficient = .62 ($P/2 < .0005$)

Effectiveness of Norms: Only 68% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 86% would have been good workers. 32% of the non-test-selected workers used for this study were poor workers; if the workers had been test-selected with the above norms, only 14% would have been poor workers. The effectiveness of norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	68%	86%
Poor Workers	32%	14%

SAMPLE DESCRIPTION

Size: N=50

Occupational Status: Employed workers

Work Setting: Los Angeles County, California and Newark, Ohio.

Employer Selection Requirements:

Education: No requirement

Previous Experience: No requirement

Tests: One company uses the Wonderlic Personnel Test and a company devised technician test based mainly on knowledge of electrical principles and wiring diagrams. However, the test results are not used as absolute determinants in the hiring process.

Other: Personnel interview

Principal Activities: The job duties for each worker are comparable to those shown in the job description in the Appendix.

Minimum Experience: All workers had completed an on-the-job training period of from two to five months.

TABLE 2

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

	Mean	SD	Range	r
Age (years)	32.9	9.1	18-58	-.266
Education (years)	11.9	1.3	8-16	.059
Experience (months)	55.8	55.5	3-300	-.161

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002A were administered during the period April 1962 through January 1965.

CRITERION

The criterion data consisted of supervisory ratings of job proficiency. Ratings and reratings for each worker were made at approximately the same time as the tests were administered with a time interval of from two to five weeks between the two ratings.

Rating Scale: An adaptation of the USES Descriptive Rating Scale was used. The scale (see Appendix) consisted of nine items (each on separate sheets of paper) with five alternatives for each item. The alternatives indicate the different degrees of job proficiency.

Reliability: The coefficient of reliability between the two ratings was .965 indicating a highly significant relationship. The final criterion score consisted of the combined scores of the two sets of ratings.

Criterion Score Distribution:

Possible Range:	18-90
Actual Range:	32-82
Mean:	62.5
Standard Deviation:	11.1

Criterion Dichotomy: The criterion distribution was dichotomized into high and low groups by placing 32% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers".

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes G, N, S, P, Q, and M were considered for inclusion in the test norms on the basis of the qualitative and statistical analyses. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - Intelligence	Required to learn and understand gyroscopic principles and theory. Required to know the procedures of the various tests, and how to carry out inspections which will insure that workmanship of gyroscope is in conformance with company quality control standards. Required to determine sequence of tests. Required to interpret test data and make decisions.
V - Verbal	Required to read and understand test procedure instructions. Required to fill out test data forms. Required to complete failure reports.
N - Numerical Aptitude	Required to make calculations involved in test procedures, including ratios.
P - Form Perception	Required in visual examination of gyroscope for workmanship and conformance with quality control standards. Required to perceive pertinent detail of gyroscope components and their interrelationships during the application of tests.

Q - Clerical Perception	Required to perceive pertinent detail by observing and recording data, reading dials and meters, measuring dimensions, and making comparisons. Required to record data accurately, check data for completeness, and fill out test procedure forms.
M - Manual Dexterity	Required to move hands skillfully in placing and turning motions to mount gyroscopes in various holding devices and fixtures. Required to manually tilt and level tables, position fixtures, connect cables to instruments; and to handle gyroscopes, test panel knobs, wrenches, cables, and fixtures.

TABLE 4

Means, Standard Deviations (SD), and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

Aptitude	Mean	SD	r
G - Intelligence	113.0	15.8	.454**
V - Verbal Aptitude	107.3	15.3	.267
N - Numerical Aptitude	108.9	16.4	.449**
S - Spatial Aptitude	113.4	20.5	.377**
P - Form Perception	108.5	20.9	.364**
Q - Clerical Perception	107.2	12.2	.300*
K - Motor Coordination	101.7	19.0	.147
F - Finger Dexterity	103.2	17.8	.096
M - Manual Dexterity	107.5	19.0	.294*

*Significant at the .05 level
**Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	x	x	x		x	x			x
Irrelevant									
Relatively High Mean	x		x	x	x				
Relatively Low Sigma						x			
Significant Correlation with Criterion	x		x	x	x	x			x
Aptitudes to be Considered for Trial Norms	x		x	x	x	x			x

DERVIATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of aptitudes G, N, S, P, Q and M at trial cutting scores were able to differentiate between the 68% of the sample considered good workers and the 32% of the sample considered poor workers. Trial cutting scores at five point intervals approximately one standard deviation below the mean are tried because this will eliminate about 1/3 of the sample with three-aptitude norms. For four-aptitude trial norms, cutting scores of slightly less than one standard deviation below the mean will eliminate about 1/3 of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of N-95, S-90, and M-80 provided the highest degree of differentiation for the occupation of Inspector, Mechanical and Electrical 6-99.435. The validity of these norms is shown in Table 5 and is indicated by a Phi Coefficient of .62 (statistically significant at the .0005 level).

TABLE 6

Concurrent Validity of Test Norms, N-95, S-90 and M-80

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	3	31	34
Poor Workers	11	5	16
Total	14	36	50

Phi Coefficient (Ø) = .62
Chi Square (X^2) = 19.38
Significance Level = $P/2 < .0005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating the occupation studied into any of the 36 OAP's included in Section II of the Guide to the Use of the General Aptitude Test Battery. The data for this sample will be considered for future groupings of occupations in the development of new occupational aptitude patterns.

A-P-P-E-N-D-I-X

JOB DESCRIPTION

Job Title: Inspector, Mechanical and Electrical (elec. equip.) 6-99.435

Job Summary:

Inspects and tests free and rate gyroscopes for conformance with company quality control standards, using equipment such as test panel, special fixtures, rate table, vibration tester, Scorsby table, Wheatstone bridge, megger, and hi-pot tester.

Work Performed:

A. Receives work and instructions from leadman: Examines appearance and workmanship of gyro for conformance with company quality control standards. Reads over test procedure to determine sequence of tests, if sequence is optional, type of tests required, and specifications of tests.

B. Performs following duties when testing rate gyros:

1. Tests for insulation resistance: Clamps lead wires of 500 volt DC megger to terminals of gyro to test for shorts in terminals. Applies specified amount of voltage to terminals and obtains reading in megohms. Clamps lead wires of hi-pot tester to terminals to determine leakage of alternating current. Repeats test with megger. Records results on test procedure.

2. Tests rotor performance: Mounts gyro in fixture and places it on rate table. Plugs test cable into gyro and test panel. Turns switch on test panel to energize rotor and, at same time, starts stop watch. Observes and records starting current voltage on current monitors in test panel. Observes monitors until rotor is turning at specified speed, stops watch, and records run-up time. Reads current monitor meters and records running current voltage.

10

3. Calibrates gyro: Positions gyro and fixture on rate table so that input axis is parallel to axis of table rotation. Sets various input rates in table. Turns on rate table and rotates gyro at specified clockwise and counterclockwise rates. Increases speed of rotation to correspond with points in test procedure. Monitors and records output, using DC output monitor on test panel. Turns off switch to stop rotor in gyro. Simultaneously, starts stop watch and waits for rotor to stop. Records length of time required for rotor to stop. Checks rotor balance of gyro by observing fluctuations of needle on output monitor of test panel.

4. Tests gyro with Wheatstone bridge: Connects terminals of gyro to lead wires of Wheatstone bridge. Measures potentiometer resistance and heater resistance of gyro and records results.

5. Performs pre-shipment tests: Mounts gyro in fixture and places it on rate table. Plugs cable in gyro and test panel. Energizes circuits with specified voltage. Starts stop watch to record run-up time of rotor. Monitors meters and records heater current. Monitors output on oscilloscope and voltage ratio meter for evidence of discontinuity or signs of abnormal output. Examines data entered on test procedure for completeness.

C. Performs following duties when testing free gyros:

1. Conducts pre-performance tests: Inspects pickoff wiring, following installation and wiring diagram. Connects instrument to free gyro

test panel, uncages gimbals, and with rotor energized, rotates inner gimbal at specified rate in each direction by hand. Monitors oscilloscope for continuity of output voltage. Repeats procedure rotating outer gimbal in each direction by hand. Examines workmanship and appearance of gyro for conformance with company quality control standards. Measures dimensions of gyro for conformance with dimensions specified in assembly drawings, using mechanical measuring instruments. Tests insulation resistance between each connector pin and case of gyro with 500 volt DC megger.

2. Tests gyro for drift under vibration: Mounts gyro in fixture and bolts fixture on vibration tester. Plugs in cable and attaches vibration pickoff directly on gyro mounting fixture. Turns on test panel to energize gyro and uncages gyro. Adjusts dual channel recorder to sensitivity of specified degree of angular displacement for each gimbal. Turns on dual channel recorder to record pickoff outputs and scans frequency spectrum. Records instrument serial number and test number on each tape. Records initial and final value of voltage ratio for each pickoff and time required for test. Checks oscilloscope for noise level of gimbals.

3. Tests gyro for pickoff continuity: Mounts gyro on fixture so that it can be rotated about either gimbal axis. Connects outer gimbal pickoff through continuity circuit of vibration station free gyro test panel with output connected to oscilloscope. With rotor energized, uncages gimbals and rotates gyro at specified rate about

outer gimbal axis in each direction from caged position. Checks for evidence of discontinuity in active and shorted sections of pickoff. Repeats procedure with inner gimbal pickoff output connected to oscilloscope, rotating gyro about inner gimbal axis.

4. Determines drift rates: Positions mounted gyro on Scorsby table and uncages energized gyro. Determines and records pickoff voltage ratios. Manually tilts Scorsby table to rock gyro in specified direction and turns on table switch. Levels table after three minutes of running time, and redetermines pickoff voltage ratios by reading test panel meters. Allows instrument to remain level for three minutes and reads meters. Records pickoff voltage ratio after another three minute run. Repeats test for positions specified in test procedure.

5. Tests pickoffs for null output: Ascertains that clockwise rotation of gyro case about each gimbal axis produces increasing voltage ratio as measured by test panel. Mounts gyro in fixture, positions it on level surface, and energizes rotors. After specified run-up time, uncages gimbals. Determines pickoff voltage ratio by manipulating dials of ratio transformer to obtain null or zero reading on phase meter. Repeats procedure specified number of times and records data that results in largest uncaged output.

6. Calibrates for output and linearity: Positions mounted gyro so that instrument can be rotated about inner gimbal axis and energizes rotor. After specified running time, uncages gyro and records voltage ratio. Rotates case 5 degrees in clockwise direction,

returns gyro to zero degree, and reads voltage ratio. Determines pickoff voltage ratio with gyro rotated 5 degrees in counterclockwise direction. Continues calibration by recording pickoff voltage ratios in 5 degree increments in each direction, recording voltage ratio between each measurement at zero degree. Repeats procedure with gyro positioned to measure output about outer gimbal axis. Cages and uncages gyro once every two minutes at zero degree. Calculates and records sensitivity of each pickoff in each direction from caged position of gimbal axis.

7. Tests for dead space: Mounts gyro in dead space measuring fixture and plugs cable into unit. Records pickoff output on recorder. Calibrates recorder and sets speed at prescribed rate. Positions fixture on rate table. Turns on test panel to energize gyro. Uncages gimbals and turns rate table in counterclockwise direction by hand. Allows rate table to turn in clockwise direction. When table is up to required speed, starts recorder, and allows fixture to rotate with table for specified degree of gimbal motion. Measures tape length at position corresponding to ground point. Records tape length and calculates and records inner gimbal dead space in degrees. Repeats procedure to measure dead space of outer gimbal pickoff.

8. Tests cage-uncage mechanism of gyro: Positions mounted gyro as specified to rotate it about outer gimbal axis. Energizes rotor, uncages gimbals, and rotates case 5 degrees counterclockwise direction. Records time required to cage gyro with caging

mechanism energized with lesser amount of volts. Determines caging time after gyro is stabilized. Connects indicator circuits to lamps so that they will indicate when gyro is caged or uncaged. Verifies proper function of circuits by caging and uncaging gyro several times. Records total rotor running time and number of cage-uncage cycles accrued during subassembly, final assembly, and final inspection.

D. Checks data prior to shipment: Fills out failure reports for instruments that fail to pass any portion of test, indicating nature of failure conditions, cause of failure, and corrective action required. Inspects test data for completeness and certifies that data is checked for compliance to specified requirements of test proedure.

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

Score_____

RATING SCALE FOR_____

Directions: Please read the form "Suggestions to Raters" and then fill in the items listed below, only one box should be checked.

Name of worker_____
(Last) (First) (Initial)

How long have you supervised this worker or been familiar with her (his) job performance?

- ☐ Under one month.
- ☐ One to two months.
- ☐ Three to five months.
- ☐ Six months or more.
- ☐ See her (him) at work all the time.
- ☐ See her (him) at work several times a day.
- ☐ See her (him) at work several times a week.
- ☐ Seldom see her (him) in work situation.

Rated by_____ _____ _____
(Signature) (Title) (Date)

HOW LARGE A VARIETY OF JOB DUTIES CAN HE PERFORM EFFICIENTLY? (Worker's ability to handle several different operations in his work.)

( ) **Cannot perform different operations adequately.**

( ) **Can perform a limited number of different operations efficiently.**

( ) **Can perform several different operations with reasonable efficiency.**

( ) **Can perform many different operations efficiently.**

( ) **Can perform an unusually large variety of different operations efficiently.**

HOW MUCH DOES HE KNOW ABOUT HIS JOB? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

( ) Has very limited knowledge. Does not know enough to do his job adequately.

( ) Has little knowledge. Knows enough to "get by".

( ) Has moderate amount of knowledge. Knows enough to do fair work.

( ) Has broad knowledge. Knows enough to do good work.

( ) Has almost complete knowledge. Knows enough to do outstanding work.

HOW MUCH WORK CAN HE (SHE) GET DONE? (Worker's ability to make efficient use of his or her time and to work at high speed.)

( ) Capable of very low work output. Can perform only at an unsatisfactory pace.

( ) Capable of low work output. Can perform at a slow pace.

( ) Capable of fair work output. Can perform at an acceptable but not fast pace.

( ) Capable of high work output. Can perform at a fast pace.

( ) Capable of very high work output. Can perform at an unusually fast pace.

HOW GOOD IS THE QUALITY OF HIS WORK? (Worker's ability to do high-grade work which meets quality standards.)

( ) Performance is inferior and almost never meets minimum quality standards.

( ) The grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.

( ) Performance is acceptable but usually not superior in quality.

( ) Performance is usually superior in quality.

( ) Performance is almost always of the highest quality.

HOW ACCURATE IS HE IN HIS WORK? (Worker's ability to avoid making mistakes.)

( ) Very inaccurate. Makes very many mistakes. Work needs constant checking.

( ) Inaccurate. Makes frequent mistakes. Work needs more checking than is desirable.

( ) Fairly accurate. Makes mistakes occasionally. Work needs only normal checking.

( ) Accurate. Makes few mistakes. Work seldom needs checking.

( ) Highly accurate. Rarely makes a mistake. Work almost never needs checking.

CONSIDERING ALL THE FACTORS ALREADY RATED, AND ONLY THESE FACTORS, HOW ACCEPTABLE IS HIS WORK? (Worker's "all-around" ability to do his job.)

( ) Would be better off without him. Performance usually not acceptable.

( ) Of limited value to the organization. Performance somewhat inferior.

( ) A fairly proficient worker. Performance generally acceptable.

( ) A valuable worker. Performance usually superior.

( ) An unusually competent worker. Performance almost always top notch.

HOW QUICKLY DID HE LEARN THE JOB DUTIES AND NEW TASKS OR OPERATIONS? (Worker's ability to learn rapidly the work he has to do.)

( ) Learned very slowly. Needed careful and repeated instructions.

( ) Somewhat slower than most in learning the job and in grasping new phases of his job.

( ) Learned most things about his job in the usual amount of time.

( ) Caught on quickly to most of the job duties he had to learn.

( ) Learned rapidly. Needed only the minimum amount of training or instructions for even the difficult job duties.

HOW MUCH APTITUDE OR FACILITY DOES HE HAVE FOR THIS KIND OF WORK? (Worker's adeptness or knack for performing his job easily and well.)

( ) Has great difficulty doing his job. Not at all suited to this kind of work.

( ) Usually has some difficulty doing his job. Not too well suited to this kind of work.

( ) Does his job without too much difficulty. Fairly well suited to this kind of work.

( ) Usually does his job without difficulty. Well suited to this kind of work.

( ) Does his job with great ease. Exceptionally well suited for this kind of work.

HOW RESOURCEFUL IS HE WHEN SOMETHING DIFFERENT COMES UP OR SOMETHING OUT OF THE ORDINARY OCCURS? (Worker's ability to apply what he already knows to a new situation.)

( ) Very unresourceful. Almost never is able to figure out what to do. Needs help on even minor problems.

( ) Unresourceful. Often has difficulty handling new situations. Needs help on all but simple problems.

( ) Fairly resourceful. Sometimes knows what to do, sometimes doesn't. Deals with most problems that are not too complex.

( ) Resourceful. Usually handles new situations. Needs help on only complex problems.

( ) Very resourceful. Practically always figures out what to do himself. Rarely needs help, even on complex problems.